

Zukunft Bau

SHORT REPORT

Title

Development, evaluation and simulation-based analysis of a new type of energy efficient system to provide domestic hot water by using decentralized micro heat pumps powered by centrally provided regenerative heat supply.

Motivation

Due to improved insulation of the building envelope, the energy demand of heating systems has decreased steadily over the past years. Nevertheless, the energy consumption for domestic hot water generation has been given almost no attention at all, although, the share of domestic hot water generation of the total end energy consumption for industry, traffic, households and commercial business ranges around 5 percent. Focusing only on private households, the share was almost 13 percent in 2011. These numbers show that there exists a considerable possible savings. Hence, this research project examined several possibilities to increase efficiency of domestic hot water generation by using micro heat pumps.

Content

This research project examines a new type of energy efficient domestic hot water generation by using decentralized micro heat pumps, supplied by centrally provided energy. Within the scope of this work, several different systems will be developed, proportionated, simulated and analyzed. Regardless, the state-of-the-art considering hygienic and energetic aspects is always taken into consideration.

One of the advantages of decentralized systems versus centralized domestic hot water generation lays in a lower flow temperature and, consequently, less heat losses in the pipes due to shorter distances between heat generation and heat sink. While central systems must provide flow temperatures above 60°C due to hygienic reasons at all times, decentralized systems can provide hygienically flawless domestic hot water using much lower temperatures. Since the efficiency of heat pumps increases with decreasing flow temperature, this system is predestined for the use of decentralized micro heat pumps. By using decentralized energy storages, the power consumption of the micro heat pump can be reduced even further and offers possibilities to save thermal energy.

A universally applicable method for dimensioning the system is presented and followed by a simulation in Matlab/ Simulink.

The simulation results suggest that the previous dimensioning meets the predefined comfort criteria. An energetic evaluation presents comparisons of the simulation results to representative systems. These results certify a considerable saving in primary energy for the newly designed system.

The system is able to reach a seasonal performance factor of 3.8 for domestic hot water generation using geothermal energy. Changing the heat source from geothermal energy to domestic waste water indicates even higher system efficiency due to the high temperature of the domestic waste water.

Based on the simulation results, the annuity of different system variations is compared within an economic feasibility study. The results show that with the current assumptions, the new

system is not economically favorable compared to conventional domestic hot water generation. The main reasons consist of the relatively low energy prices for fossil fuels and the high investment costs for the technical equipment of the new system.

Conclusion

The simulation results show that the new system provides a considerable amount of primary energy savings. With the use of geothermal energy and decentralized micro heat pumps, the system provides a primary energy savings potential of 35 percent. Due to the high investment costs, the system is not economically favorable compared to conventional domestic hot water generation.

Key data

Domestic hot water supply by decentralized heat pump systems

Research group / project manager:

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Total costs: 139,900.00 €

Quota state grant: 93,300.00 €

Project duration: till 05.11.2014

Figures:

Figure 1: Pic1_heatpumpsystem.jpg

Concept of a heat pump system with decentralized heat pumps and centrally provided ground source heat energy

Figure 2: Pic2_conventional.jpg

Conventional central heat pump system for comparison

Figure 3: Pic3_heatpumpsystem.jpg

Concept of the heat pump system with decentralized heat pumps and centrally provided waste water heat energy

Figure 4: Pic4_conventionell.jpg

Conventional system powered by a gas condensing boiler for comparison

Table 1: table1_efficiencycomparison.jpg

Comparison of the efficiency of the different variations